June 10, 1969 R. M. MISON 3,449,697

ATTENUATOR WHEREIN SHUNT CAPACITIVE LOADING CANCELS SERIES CAPACITIVE SIGNAL LEAK AT HIGHER FREQUENCIES

Filed Oct. 19, 1967

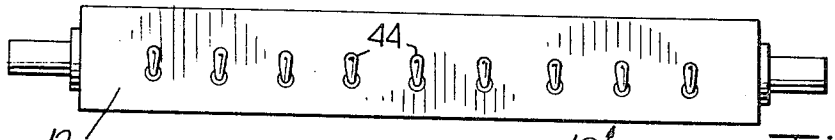


Fig. 1.

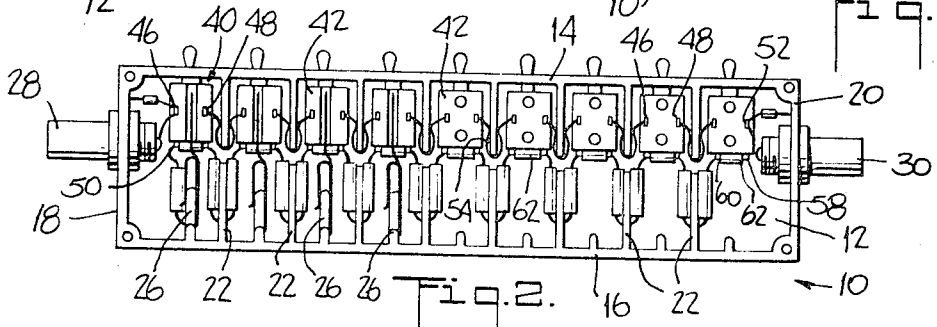


Fig. 2.

Fig. 3.

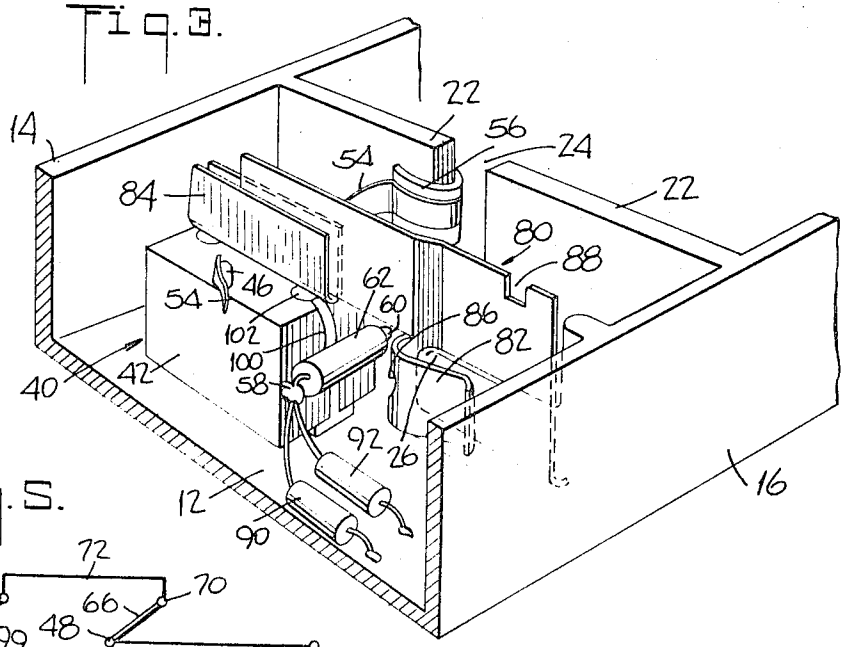
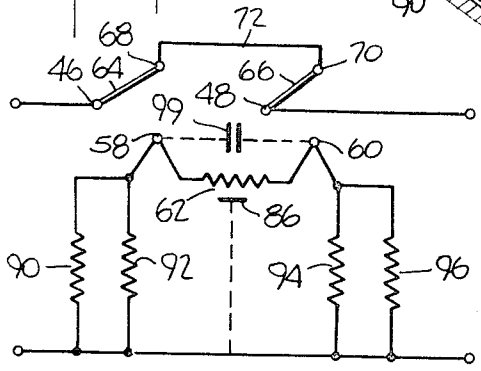


Fig. 5.



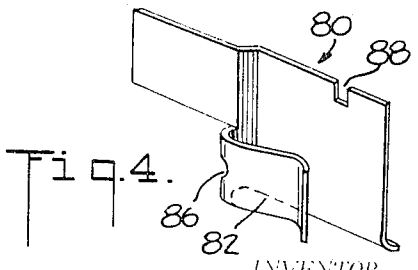


Fig. 4.

INVENTOR.
RICHARD M. MISON
BY Arthur A. March
ATTORNEY

United States Patent Office 3,449,697
Patented June 10, 1969

3,449,697

ATTENUATOR WHEREIN SHUNT CAPACITIVE LOADING CANCELS SERIES CAPACITIVE SIGNAL LEAK AT HIGHER FREQUENCIES

Richard M. Mison, Wayne, N.J., assignor to Ohmega Laboratories, Pine Brook, N.J., a partnership

Filed Oct. 19, 1967, Ser. No. 676,554
Int. Cl. H01p 1/22; H04b 3/04
U.S. Cl. 333—81 18 Claims

ABSTRACT OF THE DISCLOSURE

An attenuator for use at very high frequencies using pi attenuator sections for producing high attenuation per section. Each section is shielded from the adjacent section if there are two or more sections and one or more sections have a sliding shield to isolate the input terminal of the section from the output terminal to balance the inherent capacitance loss in order to equalize the frequency response.

The present invention relates to high frequency attenuators and, more particularly, to a switch type step attenuator of relatively high capacity.

Previous step attenuators have been limited to relatively low attenuation per step at relatively low frequencies such as a maximum of 20 db per step at 1,000 megacycles. The reason for the relatively low attenuation per step is that relatively high frequency signals have a tendency to jump across the switch contacts thereby avoiding attenuation provided guided by a pi-section attenuator had connected to the switch contacts.

It is an object of the present invention to provide a novel attenuator that provides for relatively large attenuation at relatively high frequencies.

It is another object of this invention to provide such an attenuator in the form of a switch type step attenuator that provides a relatively large attenuation per step at relatively high frequencies.

It is another object of this invention to provide such an attenuator that utilizes an adjustable slidable shield to provide relatively high attenuation at relatively high frequencies.

It is a further object of this invention to provide such an attenuator that has a sliding shield, which is movable relative to a series resistance of a pi-section attetnuator pad, that provides a capacitance which increases or decreases attenuation at high frequencies depending on the relative position of the shield to the series resistance.

Other objects and advantages will be readily apparent from the following detailed specification and the attached drawings wherein:

FIGURE 1 is a front view of a toggle switch type step attenuator embodying this invention;

FIGURE 2 is a top view of the attenuator of FIGURE 1 with the cover plate removed for clarity of illustration;

FIGURE 3 is a perspective view of one of the compartments of the attenuator of FIGURE 1 adapted to attenuate relatively high frequency signals;

FIGURE 4 is a perspective view of the sliding shield of the attenuator compartment of FIGURE 3;

FIGURE 5 is a diagrammatic view of the circuit of the compartment of the attenuator illustrated in FIGURE 3.

It has now been found that the foregoing objects and other advantages can be readily attained in an attenuator for high frequency signals having a housing means with switch means mounted in the housing, the switcth means having input and output contacts. Pi-section attenuator circuit means is connected to the input and output contacts of the switch means. Advantageously, a shield is

mounted in the housing and positioned generally adjacent a point between the input and output contacts of the switch means. The shield has a portion positioned adjacent the pi-section attenuator means to effect a capacitance between the portion of the shield and the pi-section attenuator circuit means to attenuate high frequency signals.

Desirably, the shield is movably mounted on the housing relative to the pi-section attenuator means. To accomplish this the shield has a resilient portion slidably engaged with a portion of the housing. In addition, a shield guide is mounted on the switch means, and a portion of the shield is slidably disposed therein. The housing means may have a shielding portion extending towards the switch means and the shield may have a resilient clip portion adapted to slidably engage the shielding portion of the housing.

The pi-section attenuator means is provided with a series resistor connected between the input and output contacts of the switch means. A portion of the shield is positioned adjacent the series resistor to effect a capacitance between this portion of the shield and the resistor to attenuate high frequency signals. The shield is movably mounted in the housing relative to the series resistor so that movement of the shield towards the series resistor increases attenuation of high frequency signals and movement of the shield away from the series resistor decreases attenuation of high frequency signals. The shield has a cut-out portion shaped to fit about the series resistor to increase attenuation when it is moved relatively close to this resistor.

In addition, the pi-section attenuator circuit means has a pair of shunt resistors, one of the ends of one of the shunt resistors being connected to the input contact and its other end being grounded to the housing. The other of the shunt resistors has one end connected to output contact in its opposite end grounded to the housing. The shunt resistors may also be in the form of two pairs of shunt resistors connected in a similar manner to the single pair of shunt resistors.

The switch means is provided with a by-pass circuit so that signals passing through the switch means can by-pass the pi-section attenuator means when the switch is in the out position. When the switch is in the in position, the signal passes through the pi-section attenuator means. The switch means may also have a shielding wire extending on the housing of the switch means generally between the input and output contacts to increase the shielding of the device.

This invention is advantageously provided in the form of a step attenuator having housing means divided into compartments. Switch means are mounted in each of the compartments and the output contacts of the switch means in one of the compartments are connected to the input contacts of the switch means in an adjacent compartment. PI-section attenuator circuit means is connected to the input and output contacts of each of the switch means. In one or more compartments where it is desired to have relatively high attenuation in a single step, a shield is mounted adjacent the switch means therein and positioned generally adjacent a point between the input and output contacts of the switch means in a manner similar to that described above.

Accordingly, the attenuator of this invention may be in the form of a switch type step attenuator having a plurality of attenuator units of different db attenuation values. By advantageously providing a shield in accordance with this invention in one or more of the compartments it is possible to have 30 db attenuation per step up to 1600 megacycles.

Referring now to the drawings, there is illustrated a toggle switch attenuator having an integrally formed metal housing, generally designated by the numeral 10,

having a front wall 12, upwardly extending parallel side walls 14 and 16 and end walls 18 and 20 provided at opposite ends of the side walls 14 and 16. A cover plate, not shown for clarity of illustration, is adapted to fit over and engage the side walls 14 and 16 and end walls 18 and 20 in order to enclose the attenuator housing 10. As illustrated in FIG. 2, the housing 10 is divided into compartments by means of separating walls 22. Each of the separating walls 22 has a U-shaped slot 24 adjacent the center portion thereof providing a passage between the compartments. The four compartments on the left hand side, as viewed in FIG. 2, each have a shielding portion 26 which extends generally perpendicular from the side wall 16 into the compartments midway between the separating walls 22.

Mounted on the end walls 18 and 20 are connectors 28 and 30 for engagement with cooperating connectors (not shown) of external coaxial cables for insertion of the toggle switch attenuator into a microwave circuit.

A toggle switch, generally designated by the numeral 40, is mounted in each of the compartments adjacent the side wall 14. Each toggle switch 40 has solid silver contacts set in a plastic housing 42 of Teflon that is mounted on the front wall 12 and has a manually operable toggle type handle extending through the front wall 12 for facile actuation of the switch 40.

Each toggle switch 40 has a pair of spaced poles 46 and 48 on opposite side of the housing 42 that extend upwardly through the top thereof. As illustrated in FIGURE 2, the toggle switch 40 in the compartment adjacent the end wall 18 has its pole 46 engaged with the connector 28 by means of a conductor 50. Similarly, the toggle switch 40 in the compartment adjacent the end wall 20 has its pole 48 connected to connector 30 by means of a conductor 52. The toggle switches 40 in each compartment are each connected to the next adjacent toggle switch 40 by means of a conductor 50 which extends through the U-shaped slot 24 in the separating walls 22 for connection to the poles 46 and 48 of the adjacent toggle switches 40. The conductor 54 is insulated from the separating wall 22 by means of an insulator 56.

In addition, each toggle switch 40 has a pair of spaced contacts 58 and 60 which extend from opposite sides of the front of the switch housing 42 toward the sidewall 16. A series resistor 62 is connected between each of the contacts 58 and 60 forming part of a "pi-section" attenuator pad.

As illustrated diagrammatically in FIGURE 5, the toggle switches 40 have switching members 64 and 66 which are engaged with poles 46 and 48 on one end thereof. The opposite ends of the switching members 64 and 66 are movable to engage contacts 58 and 60 to connect the poles 46 and 48 across the series resistor 62 when the respective toggle switch 40 is in the "in" position. When the respective toggle switch 40 is positioned in the "out" position, the movable ends of the switch members 64 and 66 engage a pair of spaced contacts 68 and 70 having a conductor 72 therebetween providing a short circuit between the contacts 68 and 70 thereby by-passing the series resistor 62 and the "pi-section" attenuator pad of that particular compartment.

Accordingly, the signal path through a compartment having a toggle switch 40 in the "in" position is into the switch pole 46 on one side of the housing 40 via conductor 50 or 54, through the switch member 64 to the contact 58, then through the "pi-section" attenuator pad with series resistor 62, to the contact 60, and through the switch member 66 to the switch pole 48. The signal then passes to the next toggle switch 40 via conductor 54 or to the connector 30 via the conductor 52. When the respective toggle switch 40 is in the out position the signal by-passes the "pi-section" attenuator pad and passes through a short circuit via the contacts 68 and 70 and the conductor 72.

Advantageously, in order to provide relatively high attenuation of high frequencies signals in the four compartments on the left hand side of the housing 10, as viewed in FIGURE 2, a sliding shield, generally designated by the numeral 80, is provided in each of these four compartments. The sliding shield 80 has a relatively resilient clip portion 82 which is folded back upon the shield 80 and slidably engages the shielding portion 26 extending into these compartments from sidewall 16. The resilient portion 82 acts as a clip to hold the shield 80 in sliding engagement with the shielding portion 26. On the end opposite to the resilient clip portion 82, a portion of the shield 80 is slidably disposed in a U-shaped shield guide 84 which is mounted on the center portion of the top of the toggle switch housing 42 midway between the poles 46 and 48. The shield 80 is also in sliding contact with a metallic gasket (not shown) on the cover of the housing 10. Desirably, the sliding shield 80 has a shaped cut out 86 adapted to the shape of the series resistor 62. A notch 88 is provided in the shield 80 for adjusting the position of the shield 80 relative to the series resistor 62 by means of an appropriate tool. At high frequencies, attenuation of the signal in the compartments having the sliding shield 80 may be adjusted by sliding the sliding shield 80 toward or away from the series resistor 62, movement toward the series resistor 62 causing an increase in attenuation and movement away from the series resistor 62 causing a decrease in attenuation.

The attenuation of a pi-section attenuator such as that shown diagrammatically in FIG. 5 is nominally based on the values of the series resistor 62 and shunt resistors 90–96, but this nominal value is only true for frequencies low enough so that the signal is not affected by stray capacitances in the attenuator. At high frequencies the inherent capacitance 98 between the contacts 58 and 60 exerts an increasingly detrimental effect since it provides an additional signal path that by-passes the attenuating resistors. The value of this inherent capacitance 98 is reduced by the addition of the shield 80 but it cannot be reduced to zero. Since a high attenuation requires a relatively high resistance for the resistor 62, the shunting effect of even a small capacitance 98 limits the highest frequency at which the section can provide the nominal value of attenuation.

However, in accordance with the present invention the shield 80 provides an additional shunt capacitance in which the conductive portion of the resistor 62 forms one terminal and the edge of the cut out 86 in the shield 80 forms the other. This capacitance acts to attenuate high frequency signals by providing a lower impedance path to ground, and by balancing the effect of this capacitance against the effect of the capacitance 98, the attenuation of the section shown in FIG. 5 can be maintained at a higher value to a higher frequency than has heretofore been obtainable. In effect, the highest frequencies in which the attenuator is useful are attenuated to a significant degree by the capacitances and the lower frequencies are attenuated almost exclusively by the resistors.

A shielding wire 100 may be connected from a rivet 102 on the top of the switch housing 40 to a grounded plate 104 on the under side of the switch housing 40 to provide additional shielding.

Having thus described my invention, I claim:

1. An attenuator for high frequency signals comprising housing means, switch means mounted in said housing, said switch means having input and output contacts, pi-section attenuator circuit means connected to said input and output contacts of said switch means, a shield mounted in said housing and positioned generally adjacent a point between said input and output contacts of said switch means, said shield having a

portion positioned adjacent said pi-section attenuator means to effect a capacitance between said portion of said shield and said pi-section attenuator circuit means to attenuate high frequency signals.

2. The attenuator of claim 1 wherein said shield is movably mounted in said housing relative to said pi-section attenuator means.

3. The attenuator of claim 2 wherein said shield is movably mounted in said housing by resilient portion of said shield slidably engaged with a portion of said housing and by a shield guide mounted on said switch means, said shield guide having a portion of said shield slidably disposed therein.

4. The attenuator of claim 1 wherein said pi-section attenuator means has a series resistor connected between said input and output contacts of said switch means, wherein said portion of said shield is positioned adjacent said series resistor to effect a capacitance between said portion of said shield and series resistor to attenuate high frequency signals.

5. The attenuator of claim 4 wherein the said shield is movably mounted in said housing relative to said series resistor so that movement of said shield toward said series resistor increases attenuation of high frequency signals and movement of said shield away from said series resistor decreases attenuation of high frequency signals.

6. The attenuator of claim 5 wherein said housing means has a shielding portion extending toward said switch means and said shield has a resilient clip portion adapted to a slidably engaged said shielding portion and wherein a shield guide is mounted on said switch means and a portion of said shield is slidably disposed in said shield guide for providing additional sliding support for said shield.

7. The attenuator of claim 5 wherein said shield has a cut out portion shaped to fit about said series resistor.

8. The attenuator of claim 4 wherein said pi-section attenuation circuit means has a pair of shunt resistors, one end of one said shunt resistors being connected to said input contact and its other end being grounded to said housing, the other of said shunt resistors having one end connected to said output contact and its opposite end grounded to said housing.

9. The attenuator of claim 4 wherein said pi-section attenuator circuit means has two pairs of shunt resistors, one side of one said pairs of shunt resistors being connected to said input contact and its opposite side being grounded to said housing, the other of said pair of shunt resistors having one side connected to said output contacts and their opposite side grounded to said housing.

10. The attenuator of claim 4 wherein said switch means has a by-pass circuit so that the signal passing through said switch means can by-pass said pi-section attenuator means when said switch is in the out position.

11. The attenuator of claim 6 wherein said switch means has a shielding wire extending on the housing of said switch means, generally between said input and output contacts.

12. A step attenuator comprising housing means, said housing means being divided into compartments, switch means mounted in said compartments, said switch means having output and input contacts, the output contact of said switch means in one of said compartments being connected to the input contact of said switch means in another of said compartment, a pi-section attenuator circuit means connected to the input and output contacts of said switch means, said pi-section attenuator circuit means having a series resistance connected between said input and output contacts of said switch means, a shield mounted in one of said compartments adjacent said switch means therein and positioned generally adjacent a point between said input and output contacts of said switch means, said shield having a portion positioned adjacent said series resistance to effect a capacitance between said portion of said shield and said series resistance to attenuate high frequency signals.

13. The step attenuator of claim 12 wherein said shield is movable relative to said series resistor of said pi-section attenuator circuit means, movement of said shield toward said series resistor increasing attenuation of high frequencies signals and movement of said shield away from said series resistor decreasing attenuation of high frequency signals.

14. The step attenuator of claim 13 wherein said housing means has a shielding portion in said one of said compartments and said shield has a resilient clip portion adapted to slidably engage said shielding portion, and wherein a shield guide is mounted on said switch means with a portion of said shield slidably mounted therein for providing additional sliding support for said shield.

15. The attenuator of claim 14 wherein said shield has a cut out portion shaped to fit about said series resistor.

16. The attenuator of claim 15 wherein said pi-section attenuation circuit means has a pair of shunt resistors, one end of one said shunt resistors being connected to said input contact and its other end being grounded to said housing, the other of said shunt resistors having one end connected to said output contact and its opposite end grounded to said housing.

17. The attenuator of claim 15 wherein said pi-section attenuator circuit means has two pairs of shunt resistors, one side of one said pairs of shunt resistors being connected to said input contact and its opposite side being grounded to said housing, the other of said pair of shunt resistors having one side connected to said output contact and their opposite side grounded to said housing.

18. The attenuator of claim 15 wherein said switch means has a by-pass circuit so that the signal passing through said switch means can by-pass said pi-section attenuator means when said switch is in the out position.

References Cited

UNITED STATES PATENTS

3,014,187 12/1961 Sher et al. ---------- 333—81

FOREIGN PATENTS

394,715 7/1933 Great Britain.

HERMAN KARL SAALBACH, *Primary Examiner.*

M. NUSSBAUM, *Assistant Examiner.*